CLAIMS

What is claimed is:

5   1.   A method for operating an electrolyzer for producing metal particles through electrolysis, said electrolyzer having anode and cathode surfaces at least partially immersed in an electrolyte solution including dissolved metal, the method comprising:

determining an operating range for a cell voltage across the anode and cathode surfaces;

10   supplying electrical current flow through the solution between the anode and cathode to create a cell voltage within the operating range;

monitoring the cell voltage;

adjusting the current responsive to the monitored voltage to maintain the cell voltage within the operating range, thereby forming metal particles on the cathode surface

15   by electrolysis of the dissolved metal.

2.   The method of claim 1 wherein the operating range is selected to produce a current density in the cathode greater than about 5 kA/m^2.

20   3.   The method of claim 1 wherein the dissolved metal is in a form of one or more oxides of the metal.

4.   The method of claim 1 wherein the solution is a reaction product of an electrochemical reaction in a metal/air fuel cell.

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5. The method of claim 1 wherein the dissolved metal is zinc.

6. The method of claim 1 wherein the determining step further comprises determining an optimal cell voltage and limiting the operating range to within 20% of the optimal cell voltage.

7. The method of claim 6 wherein a cell voltage within the operating range can produce a current density in the cathode between about 10 kA/m^2 and about 40 kA/m^2.

8. The method of claim 7 wherein a cell voltage within the operating range can produce a current density in the cathode of about 34,340 A/m^2.

9. A method for operating an electrolyzer, comprising:

immersing an electrolyzer having anode and cathode surfaces into an electrolyte solution, the solution including dissolved metal;

applying DC voltage to the electrolyzer to produce metal particles on the cathode surface through electrolysis;

removing metal particles from the electrolyzer when the particles achieve a desired size;

reducing the applied voltage to a value below about 1.65 volts; and

reversing polarity of the applied voltage thereby dissolving unremoved metal particles from the cathode surface.

10. The method of claim 9 wherein the reversing step further comprises reversing polarity a first time for a time period, then reversing polarity a second time and repeating the method beginning with the applying step.

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11. The method of claim 10 wherein the time period continues until embedded particles are substantially dissolved from the cathode surface.

5   12. The method of claim 10 wherein the time period is between about 60 and about 300 seconds.

13. The method of claim 9 further comprising determining an operating range for a cell voltage across the anode and cathode surfaces, monitoring the cell voltage, and

10   adjusting the DC voltage responsive to the monitored voltage to maintain the cell voltage within the operating range.

14. The method of claim 13 wherein the operating range is selected to produce a current density in the cathode greater than about 5 kA/m^2.

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15. The method of claim 13 wherein the determining step further comprises determining an optimal cell voltage and limiting the operating range to within 20% of the optimal cell voltage.

20   16. The method of claim 15 wherein a cell voltage within the operating range can produce a current density in the cathode between about 10 kA/m^2 and about 40 kA/m^2.

17. The method of claim 16 wherein a cell voltage within the operating range can produce a current density in the cathode of about 34,340 A/m^2.

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18.   The method of claim 9 wherein the dissolved metal is in a form of one or more oxides of the metal.

19.   The method of claim 9 wherein the solution is a reaction product of an electrochemical reaction in a metal/air fuel cell.

20.   The method of claim 18 wherein the dissolved metal is zinc.

21.   A method for operating an electrolyzer having anode and cathode surfaces, the method comprising:

immersing an electrolyzer at least partially within a body of electrolyte solution, the solution including dissolved metal;

supplying electrical current to the electrolyzer to create a cell voltage across the anode and cathode surfaces thereby forming metal particles on the cathode surface through electrolysis;

monitoring the cell voltage;

adjusting the current responsive to the monitored voltage to maintain the cell voltage within a predetermined range;

removing metal particles from the cathode surface when the particles achieve a desired size;

reducing the applied voltage to a value that precludes oxgen evolution on the cathode surface; and

reversing polarity of the applied voltage thereby dissolving unremoved metal particles from the cathode surface.

22. The method of claim 21 wherein the predetermined range is selected to produce a current density in the cathode between about 10,000 A/m^2 and about 40,000 A/m^2.

23. The method of claim 21 wherein the adjusting step further comprises determining an optimal cell voltage and adjusting the current responsive to the monitored voltage to maintain cell voltage within 20% of the optimal cell voltage.

24. The method of claim 23 wherein a cell voltage within 20% of the optimal cell voltage can produce a current density in the cathode of about 34,340 A/m^2.

25. The method of claim 21 further comprising monitoring peak current through the electrolyzer during the reversing step.

26. The method of claim 25 further comprising shutting off power to the electrolyzer if peak current exceeds an operating limit.

27. The method of claim 26 further comprising mechanically reconditioning the cathode surface.

28. The method of claim 21 wherein the reversing step further comprises reversing polarity a first time for a fixed time period, then reversing polarity a second time and repeating the method beginning with the supplying step.

29. The method of claim 28 wherein the time period continues until embedded particles are substantially dissolved from the cathode surface.

30.   The method of claim 28 wherein the time period is between about 60 and about 300 seconds.

31.   The method of claim 28 further comprising monitoring the peak current through the electrolyzer during the first reversing step, and if peak current exceeds an operating limit, mechanically reconditioning the cathode surface.

32.   The method of claim 21 wherein the dissolved metal is in a form of one or more oxides of the metal.

33.   The method of claim 21 wherein the solution is a reaction product of an electrochemical reaction in a metal/air fuel cell.

34.   The method of claim 21 wherein the dissolved metal is zinc.

35.   A method for operating an electrolyzer having anode and cathode surfaces, the method comprising:

a step for immersing an electrolyzer at least partially within a body of electrolyte solution, the solution including dissolved metal;

a step for supplying electrical current to the electrolyzer to create a cell voltage across the anode and cathode surfaces;

a step for monitoring the cell voltage;

a step for adjusting the current responsive to the monitored voltage to maintain the cell voltage within a predetermined range;

a step for removing metal particles from the cathode surface when the particles achieve a desired size;

a step for reducing the applied voltage to a value below about 1.65 volts; and

a step for reversing polarity of the applied voltage thereby dissolving unremoved metal particles from the cathode surface;

a step for monitoring peak current through the electrolyzer during the reversing

5   step; and

a step for reconditioning the cathode surface if peak current exceeds an operating limit.